FORSTERITIC OLIVINES FROM ANGRITES AND HOWARDITES; T. Mikouchi and M. Miyamoto, Mineralogical Institute, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Tokyo 113, JAPAN. e-mail: mikouchi@min.s.u-tokyo.ac.jp.

INTRODUCTION

Angrites and HED (howardites-eucrites-diogenites) meteorites are the oldest known igneous rocks in the solar system whose crystallization ages are around 4.56 Ga [*e.g.*, 1]. Oxygen isotopes of these meteorites are indistinguishable [2], and indicate a common parent body. Jurewicz *et al*. [3] experimentally reproduced angritic and eucritic melts by partial melting of Allende and Murchison carbonaceous chondrites, depending upon different oxygen fugacities. However, detailed comparison of these meteorites has not been performed especially in olivine mineralogy.

Angrite is a unique basaltic achondrite whose mineralogy is distinct from other achondrites. Angrites are enriched in refractory elements, and are mainly composed of fassaitic clinopyroxenes, Ca-rich olivine, and anorthitic plagioclase. LEW87051 and Asuka-881371 are contrast to the other angrites (Angra dos Reis and LEW86010) in that they contain Mg-rich olivines (up to Fo_{90}) that are interpreted as xenocrysts [*e.g.*, 4]. It is characteristic that these olivines have significant Cr (~0.6 wt% Cr_2O_3). They contain less Ca than groundmass olivines. Some porphyritic olivines show two-stage zoning, and they are concluded that the core is xenocryst and the rim is phenocryst [*e.g.*, 4]. We consider that these Mg-rich olivine xenocrysts are key minerals to understand the angrite petrogenesis in comparison with HED meteorites. We have examined HED meteorites to find Mg-rich olivines as seen in angrites in order to get insights of genetic relation between these achondrites.

ANGRITE OLIVINES

LEW87051 is porphyritic in texture and contains euhedral to subhedral olivine crystals of ~500 µm in size. Olivines are extensively zoned towards the Fe-rich rim, and typical core composition is Fo_{80}. These olivine cores are enriched in Ca (CaO: 0.6 wt%) and poor in Cr (Cr_2O_3: 0.1 wt%). It is noted that several olivines have Mg-rich cores reaching Fo_{90} (Fig. 1b and 2b). These cores contain higher Cr_2O_3 of 0.2 wt% and less CaO of 0.2 wt% than the typical core. We interpreted that these Mg-rich cores are xenocrysts that are clearly in disequilibrium with the groundmass, while olivines whose core composition is larger than Fo_{80} are phenocrysts.

Asuka-881371 is ophitic in texture, and contains coarse-grained Mg-rich (Fo_{90}) olivines reaching 2 mm across. Groundmass olivines are compositionally zoned from the Fo_{70} core to the nearly Mg-free rim. The large Mg-rich olivines are homogeneous in composition except for the rim (~100 µm from the edge) that are zoned to Ca-, Fe-rich composition, and are considered to be xenocrysts [*e.g.*, 4]. Because these olivines have Cr_2O_3 of ~0.6 wt% and CaO of 0.2-0.5 wt%, it is proposed that they share common origins with LEW87051 olivine xenocrysts [4]. Warren *et al*. [5] analyzed oxygen isotope ratios of olivine xenocrysts of Asuka-881371, and reported that they have identical values to the whole rock data.

HED OLIVINES

We have examined the catalogue of Antarctic meteorite of NIPR [6] to find Mg-rich olivines from a HED meteorite collection. Eucrites do not contain olivines except for the late-crystallized Fe-rich olivines, while howardites usually contain olivines of variable Mg-Fe compositions. The most Mg-rich olivines of them exceed Fo_{90}. Some diogenites contain olivines, but some do not. We have selected 4 Antarctic howardites (Y-7308, Y-790727, Y-791208, Y-791492) and 1 diogenites (Asuka-881548) that have Mg-rich olivines of $Fo_{>80}$.

Generally, Mg-rich olivines in howardites are small in size (~500 µm) and angular in shape. They are nearly homogeneous in composition. Most olivines of ~Fo_{80} are poor in Ca and Cr (oxide wt%: <0.1 wt%) (Fig. 1a and 2a). However, a few olivines of Fa_{10-15} have significant content of Cr (Cr_2O_3: ~0.7 wt%) (Fig. 1a). These olivines are also abundant in Ca (Fig. 2a).

Olivines in diogenites are less Mg-rich than those in howardites, and do not exceed Fo_{85}. Asuka-881548 olivines have less than 0.1 wt% CaO and Cr_2O_3.

PETROGENETIC RELATION OF Mg-RICH OLIVINES

It is noted that howardites contain Cr-, Mg-rich olivines as observed in angrites. These olivines show similar Fa-Cr distribution to angrite olivines (Fig. 1a and 1b). CaO content of howardite olivines is typically less than 0.1 wt% (Fig. 2a), but those enriched in Cr have larger CaO content comparable to angrite olivine xenocrysts.

As described above, angrite and HED meteorites have some common properties (*e.g.*, oxygen isotopes), and there is a possibility that they share a common parent body. The presence of Cr-, Mg-rich olivines observed in howardites and angrites might support this hypothesis. Such Cr-rich olivines would crystallize from primary Cr-rich melt. Cr-poor olivines ($Fa_{>15}$) in howardites would reflect Cr-poor nature of melt after chromite crystallization. The difference of Ca content in Fe-rich olivine between HED and angrites is due to difference of the Ca content in the melt. The Ca-rich angrite melt were produced somewhere different region of high fO_2 ambient in the HED parent body, and Cr-, Mg-rich olivines were somehow incorporated into the angrite melt as xenocrysts. FeO/MnO ratios in silicates are often employed to assess the possibility of same parent body and to testify the redox conditions. Unfortunately, angrites and howardites have distinctive wt% FeO/MnO ratios (angrite: 80~90, howardite: 30-40). However, some olivines in howardites have a little larger ratios of 60-70, and can not rule out the hypothesis.

Further trace element study of these olivines is required to clarify whether Mg-rich olivines from angrites and howardites have a direct genetic link each other.

References: [1] Nyquist L. E. *et al.* (1994) *Meteoritics*, ***29***, 872-885. [2] Clayton R. N. and Mayeda T. K. (1996) *GCA, **60***, 1999-2018. [3] Jurewicz A. J. G. *et al.* (1991) *Science*, ***252***, 695-698. [4] Mikouchi T. *et al.* (1996) *Proc. NIPR Symp. on Antarct. Meteorites, **9***, 879-880. [5] Warren P. H. et al. *Antarct. Meteorites*, ***XX***, 261-264. [6] Yanai K. and Kojima H. *eds*. (1995) *Catalogue of the Antarctic Meteorites*. pp. 230.

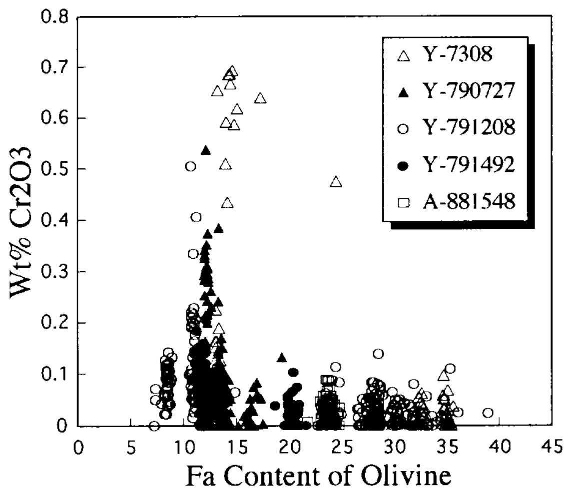

Fig 1a. Cr_2O_3 vs. Fa of howardites and diogenite olivines.

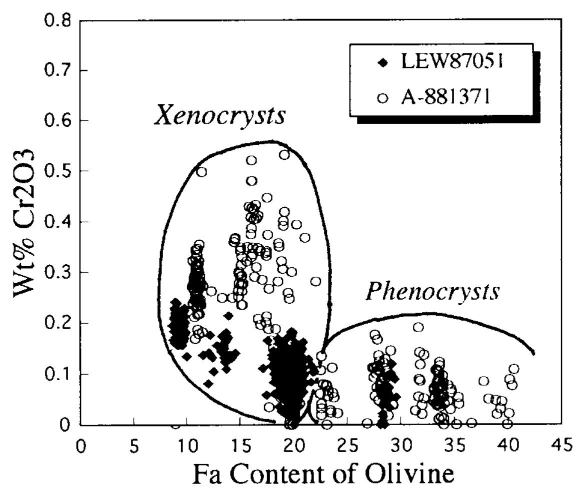

Fig. 1b. Cr_2O_3 vs. Fa of angrite olivines.

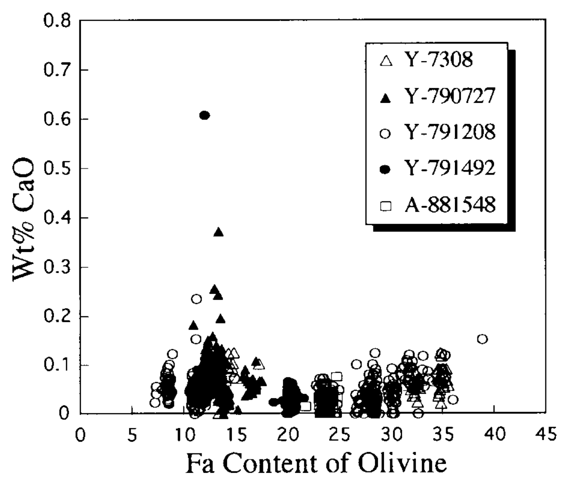

Fig. 2a. CaO vs. Fa of howardite and diogenite olivines.

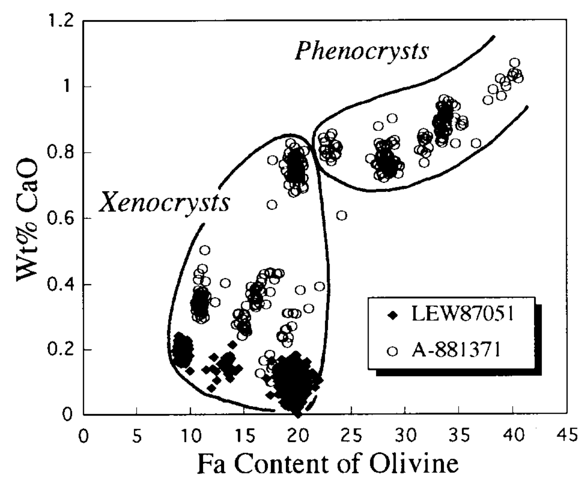

Fig. 2b. CaO vs. Fa of angrite olivines.